

**TITLE: DISTANCE MEASURING SYSTEMS AND  
METHODS THEREOF**

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## **DISTANCE MEASURING SYSTEMS AND METHODS THEREOF**

**[0001]** This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/414,572 filed September 27, 2002 which is herein incorporated by reference in its entirety.

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### **FIELD OF THE INVENTION**

**[0002]** The present invention generally relates to distance measuring systems and, more particularly, to portable or hand-held distance measuring systems of the projected energy type.

### **BACKGROUND OF THE INVENTION**

10 **[0003]** All distance measuring devices measure the distance between two points. One type of hand-held distance measuring device uses the round trip transit time of projected energy to a target and back to the device to determine distance.

15 **[0004]** Although this type of hand held measuring device works, it has some problems. One of the problems with this type of device is with establishing a reference plane from which the measurements are made. Errors in establishing the correct reference plane result in measurement errors. Another problem is that this type of hand held measuring device requires the user to manually turn the device on, as well as enter other measurement parameters, before being able to 20 perform the distance measurement.

### **SUMMARY OF THE INVENTION**

25 **[0005]** A distance measuring system in accordance with embodiments of the present invention includes a housing with at least one surface, at least one switch along the one surface of the housing, an energy system in the housing, and a distance computation system coupled to the energy system. The switch has an inactivated position and an activated position when pressed against an origination object. The activated position of the switch identifies the surface as a reference plane with respect to the origination object. The energy system transmits energy towards a target when the switch is in an activated position and receives at least a 30 portion of the energy which is reflected back from the target. The distance

computation system uses the received portion of the energy which is reflected back and the identification of the surface as the reference plane to determine a distance from the origination object to the target.

[0006] A method for making a distance measuring system in accordance with embodiments of the present invention includes providing a housing with at least one surface. At least one switch is put along the one surface of the housing. The switch has an inactivated position and an activated position when pressed against an origination object. The activated position of the switch identifies the surface as a reference plane with respect to the origination object. The energy system is placed in the housing and transmits energy towards a target when the switch is in an activated position and receives at least a portion of the energy which is reflected back from the target. The distance computation system is coupled to the energy system and uses the received portion of the energy which is reflected back and the identification of the surface as the reference plane to determine a distance from the origination object to the target.

[0007] A method for measuring a distance from an origination object to a target in accordance with embodiments of the present invention includes activating a switch in a housing. The activation identifies a surface of the housing as a reference plane with respect to a surface of the origination object. Energy is transmitted towards a target in response to the activation of the switch. At least a portion of the energy which is reflected back from the target is received. The received portion of the energy which is reflected back and the identification of the surface of the housing as the reference plane is used to determine a distance from the origination object to the target.

[0008] The present invention provides a projected energy type, distance measuring system that automatically selects the correct reference plane and powers on the unit as part of the distance measuring operation itself. The present invention also saves time and improves productivity because the device can easily be used with one hand and has a high degree of accuracy. The automatic reference plane selection in this device which is activated when the device is

activated to take a measurement eliminates the risk of an operator error in manually entering a reference plane selection.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0009] FIG. 1 is a front perspective view of a distance measuring system in accordance with embodiments of the present invention;

5 [0010] FIG. 2 is a rear perspective view of the distance measuring system shown in FIG. 1;

[0011] FIG. 3 is a bottom view of the distance measuring system shown in FIG. 1;

10 [0012] FIG. 4 is a side, cross-sectional view of the distance measuring system shown in FIG. 1;

[0013] FIG. 5 is a front perspective view of the distance measuring system in accordance with other embodiments of the present invention;

15 [0014] FIG. 6 is a top view of the of the distance measuring system shown in FIG. 5 with a hook-tab activation switch in an inactivated position;

[0015] FIG. 7 is a top view of the of the distance measuring system shown in FIG. 5 with a hook-tab activation switch in an activated position; and

[0016] FIG. 8 is a bottom, cross-sectional view of the distance measuring system shown in FIG. 6.

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#### **DETAILED DESCRIPTION**

[0017] A distance measuring system 10(1) in accordance with embodiments of the present invention is illustrated in FIGS. 1-4. The distance measuring system 10(1) includes a housing 12, an alphanumerical display device 14, activation switches 16 and 18, a projected energy generating device 20, 25 an energy receiving device 22, and a distance computation system 24, although the system 10(1) may comprise other types, numbers, and combinations of components. The present invention provides a projected energy type, distance

measuring system 10(1) that automatically selects the correct reference plane and powers on the unit as part of the distance measuring operation.

[0018] Referring more specifically to FIGS. 1-4, the housing 12 has six surfaces 26(1)-26(6) which are connected together to form a parallelepiped, 5 although the housing 12 could have other numbers of surfaces and other shapes and configurations. Surface 26(5) is substantially perpendicular to both surfaces 26(1) and 26(2) which are used as reference planes for the distance measuring system 10(1), although other surfaces of the device could be used as the reference planes. The surfaces 26(1) and 26(2) are separated about one to 10 twelve inches apart, although their spacing and orientation can vary. Surface 26(6) is also substantially perpendicular to surfaces 26(1)-26(4).

[0019] A liquid crystal alphanumerical display device 14 is located along one surface 26(6), although other types of display devices, such as an OLED, in other locations can be used. The liquid crystal alphanumerical display device 14 15 displays data, such as a measurement, to an operator of the system 10(1). The distance computation system 24 transmits the measured distance to the display device 14 for display.

[0020] A rectangular shaped aperture 28, a circular shaped aperture 30, and a recessed rectangular shaped aperture 32 are formed in the surface 26(1), 20 although each of the apertures 28, 30, and 32 could have other shapes and configurations. A section of glass 34 is secured to the housing 12 across the recessed rectangular aperture 32, although other types of transmissive materials could be used to seal the aperture 32 or the aperture 32 could be left open. The activation switch 16 is secured to the housing 12 and has a button which extends 25 out through the aperture 28, although the activation switch 16 could be connected to the housing 12 in other manners. The activation switch 16 is coupled to the projected energy generating device 20 and to the distance computation system 24, although the switch 16 can be coupled to other components and in other arrangements.

[0021] A rectangular shaped aperture 36 and a rectangular shaped aperture 38 are formed in the surface 26(2), although each of the apertures 36 and 38 could have other shapes and configurations. A door 40 is seated in the aperture 38 and is pivotally connected by hinges 42 to the housing 12 for movement between a position sealing the aperture 38 and to a position providing access through the aperture 38 to a battery compartment 44 in the housing 12. The activation switch 18 is secured to the housing 12 and has a button which extends out through the aperture 36, although the activation switch 18 could be connected to the housing 12 in other manners. The activation switch 18 is coupled to the projected energy generating device 20 and to the distance computation system 24, although the switch can be coupled to other components in other manners.

[0022] A battery 46 is located in the battery compartment 44 and is coupled to the projected energy generating device 20, the energy receiving device 22, and the distance computation system 24, although other types of power sources could be used. The battery 46 provides power to the projected energy generating device 20, the energy receiving device 22, and the distance computation system 24, although the battery 46 can be coupled to other components and in other arrangements.

[0023] Referring to FIG. 4, the projected energy generating device 20 is coupled to the distance computation system 24, activation switches 16 and 18, and the battery 46, although the projected energy generating device 20 could be coupled to other components and in other arrangements. The projected energy generating device 20 generates energy, such as laser light or electromagnetic energy, or acoustical energy, and is positioned in the housing to project the generated energy PE through the aperture 30 and substantially along an axis A-A, although other arrangements for projecting the energy PE could be used. The axis A-A of the projected energy PE is substantially orthogonal to surfaces 26(1) and 26(2) which act as the reference planes, although this orientation can vary. The projected energy generating device 20 also provides data about the projected energy PE being transmitted and the timing of transmissions of projected energy PE to the distance computation system 24. The operation of the projected energy

generating device 20 to generate and transmit the projected energy PE along the axis A-A is controlled by the distance computation system 24, although the operation of the projected energy generating system 20 can be controlled in other manners, such as in response to the activation of one of the switches 16 and 18.

5 [0024] Referring to FIGS. 1 and 4, the energy receiving device 22 is coupled to the distance computation system 24, activation switches 16 and 18, and the battery 46, although the energy receiving device 22 could be coupled to other components and in other arrangements. The energy receiving device 22 is positioned in the housing 12 to receive reflected energy RE through recessed aperture 32 which has been reflected back from a target substantially along an axis B-B, although other arrangements for receiving the energy could be used. The energy receiving device 22 also provides data to the distance computation system 24 about the received reflected energy RE and the time when the reflected energy RE is received. The operation of the energy receiving device 22 is controlled by 10 the distance computation system 24, although the operation of the energy receiving device 22 can be controlled in other manners. Although a separate projected energy device 20 and a separate energy receiving device 22 are shown, other configurations can be used, such as a transceiver system that transmits and receives the energy.

15 [0025] Referring to FIG. 4, the distance computation system 24 is coupled to the projected energy generating device 20, the energy receiving device 22, the activation switches 16 and 18, the alphanumerical display device 14, and the battery 46 in the housing 12, although the distance computation system 24 could be coupled in other manners to other components. The distance computation 20 system 24 controls the operation of and receives data from the projected energy generating device 20 and the energy receiving device 22 about the projected energy PE and reflected energy RE. The distance computation system 24 also receives data from activation switches 16 and 18 which indicate when one of the switches 16 and 18 is on. The distance computation system includes a processor 25 and memory with programmed instructions for measuring distance as described herein, although the distance computation system 24 can have other types, numbers, and combinations of components coupled in other arrangements and can 30

have other programmed instructions. In these particular embodiments, the programmed instructions include instructions for determining whether the reference plane associated with surface 26(1) or the reference plane associated with surface 26(2) is being used based on which of the activation switches 16 or 5 18 has been engaged. The programmed instructions also include instructions for determining the distance between the origination object and the target based on the time it takes the projected energy PE to return from being reflected off of the target taking into account the particular reference plane being used.

10 [0026] Referring now to FIGS. 5-8, a distance measuring system 10(2) in accordance with other embodiments of the present invention is illustrated.

Distance measuring system 10(2) is identical to distance measuring system 10(1) in structure and operation, except as set forth herein. Elements in distance measuring system 10(2) which are identical to elements in distance measuring system 10(1) will have like reference numerals and will not be described again.

15 [0027] A hook-tab activation switch 50 is slidably mounted on the surface of housing 12, although the hook-tab activation switch 50 could be mounted in other locations. The hook-tab activation switch 50 can be used to activate the distance computation system 24 to initiate a measurement procedure, to indicate to the distance computation system 24 that the reference plane on surface 26(2) has 20 been selected, and to indicate that a distance substantially equal to the distance between the surfaces 26(1) and 26(2) with the reference planes must be added to the distance computation, although the activation switch 50 can be used for other purposes. With the hook-tab activation switch 50, the distance measuring system 10(2) is useful for measuring geometries in which the measuring surface of 25 an origination object OB is not readily accessible to the activation switch 16 or the activation switch 18.

30 [0028] The height and width of the hook-tab activation switch 50 is smaller than the height and width of surface 26(3) of the housing 12, although the height and width of the hook-tab activation switch 50 could be much smaller for compactness or could be made larger than surface 26(3) for more difficult measuring geometries. The hook-tab activation switch 50 is also sized and

positioned so that the hook-tab activation switch 50 will not interfere with the operation of the activation switch 16 or the activation switch 18, nor will it interfere with accessibility to the reference plane on surface 26(1) or the reference plane on surface 26(2). Similarly, activation switch 16 and activation switch 18

5 will not interfere with the operation of the hook-tab activation switch 50 while it is being used for a measurement.

[0029] The hook-tab activation switch 50 is shown in the inactivated position in FIGS. 5, 6, and is shown in the activated position in FIG. 7. In the activated position, the hook-tab activation switch 50 is placed about a corner of

10 the origination object OB, and the user slides the housing 12 forward approximately  $\frac{1}{4}$ " to initiate the measurement. In the activated position, the plane of measurement of the origination object OB is coincident with the surface 26(2) which acts as the reference plane.

[0030] The operation of the distance measuring system 10(1) will now be

15 described with reference to FIGS. 1-4. To perform a measurement, the surface of the distance measuring system 10(1) is placed against a surface of an origination object OB from which the distance to the target will be measured. The origination object OB must be positioned not to obscure apertures 30 and 32. When the

20 surface 26(1) is brought into coincidence with the origination object OB, button of activation switch 16 is depressed.

[0031] Depressing the button of activation switch 16 signals the projected energy generating device 20 to emit projected energy PE substantially along the axis A-A through aperture 30. Depressing the button of the activation switch 16 also signals the distance computation system 24 to select the reference plane on

25 the surface 26(1) as the zero or reference plane, coinciding with the plane of the origination object OB. The projected energy generating device 20 transmits data to the distance computation system 24 about the type of energy being projected and when the energy was projected.

[0032] The projected energy PE is reflected off of the target and is sent

30 back as reflected energy RE to the energy receiving device 22 substantially along

axis B-B. The energy receiving device 22 receives the projected energy reflected back from the target through aperture 32 and sends data to the distance computation system 24 about the received reflected energy RE and the time when the reflected energy RE was received.

5 [0033] The distance computation system 24 determines the distance time based on the data received from the projected energy generating device 20 and from the energy receiving device 22 and about which surface 26(1) or 26(2) of the distance measuring system 10(1) is used as the reference plane. Since the surface 26(1) was placed at the desired starting origination plane for the  
10 measurement, the distance computation device 24 does not need to add any distance to the measurement. The process of determining distance based on the time it takes projected energy PE to be reflected back from a target is well known to those of ordinary skill in the art and thus will not be described in detail here. After the distance is computed by the distance computation system 24, the  
15 distance is transmitted to and is displayed on the liquid crystal alphanumeric display 14.

[0034] To perform another measurement, the surface 26(2) of the distance measuring system 10(1) can be placed against another surface of an origination object from which the distance to the target is to be measured. When the surface  
20 26(2) is brought into contact with the surface of the origination object, the button of the activation switch 18 is depressed.

[0035] Depressing the button of activation switch 18 signals the projected energy generating device 20 to emit projected energy substantially along the axis A-A through aperture 30. Depressing the button of the activation switch 18  
25 also signals the distance computation system 24 to select the reference plane on the surface 26(2) as the zero or reference plane, coinciding with the plane of the origination object. The projected energy generating device 20 transmits data to the distance computation system 24 about the type of energy being projected and when the energy was projected.

[0036] The projected energy PE is reflected off of the target and is sent back as reflected energy RE to the energy receiving device 22 substantially along axis B-B. The energy receiving device 22 receives the reflected energy RE and sends data to the distance computation system about the received reflected 5 energy RE and the time when the reflected energy RE was received.

[0037] The distance computation system 24 determines the distance based on the data received from the projected energy generating device 20 and from the energy receiving device 22 and about which surface of the distance measuring system 10(1) is used as the reference plane. Since the surface 26(2) was placed at 10 the desired origination plane for the measurement, the distance computation system 24 adds in a distance substantially equal to the distance from surface 26(2) to the surface 26(1). Again, the process of determining distance based on the time it takes projected energy PE to be reflected back from a target is well known to those of ordinary skill in the art and thus will not be described in detail here. 15 After the distance is computed by the distance computation system 24, the distance is transmitted to and is displayed on the liquid crystal alphanumeric display device 14.

[0038] The operation of the distance measuring system 10(2) shown in FIGS. 5-8 is the same as the operation of the distance measuring system 10(1) 20 shown in FIGS. 1-4, except as described herein. Accordingly, the process of taking a measurement using activation switch 16 or activation switch 18 in the distance measuring system 10(2) is the same as the operation of taking a measurement with the distance measuring system 10(1) described above.

[0039] To perform a measurement using the hook-tab activation switch 50, 25 the corner of the hook-tab activation switch 50 is placed firmly over the desired corner of the origination object OB such that the hook-tab activation switch 50 will not slip off the origination object OB during a distance measurement operation. Next, the housing 12 of the distance measuring system 10(2) is slid towards the target whose distance is to be measured. During the sliding operation 30 the hook-tab activation switch 50 will remain stationary and hooked on the corner of the origination object OB. When the housing 12 is slid towards the target, the

hook-tab activation switch 50 signals the projected energy generating device 20, the energy receiving device 22, and the distance computation system 24 that the system 10(2) is activated or turned on and sends a signal to the distance computation system 24 about the surface 26(2) which is being used as the reference plane. When the housing 12 is slid in this manner, a stop (not shown) is encountered which prevents the hook-tab activation switch 50 from being extended further. When this stop is reached, the surface of the origination object OB is in the same plane as the surface 26(2) of the housing 12.

[0040] As describe above, sliding the hook-tab activation switch 50 activates the system 10(2) and causes the projected energy generating device 20 to emit projected energy PE along axis A-A through aperture 30 and signals the distance computation system 24 to select surface 26(2) as the zero or reference plane, coinciding with the plane of the origination object OB.

[0041] The projected energy PE is reflected off of the target and is sent back as reflected energy RE to the energy receiving device 22 substantially along axis B-B. The energy receiving device 22 receives the reflected energy RE from the target through aperture 32 and sends data to the distance computation system 24 about the received reflected energy RE and the time when the reflected energy RE was received, although other information about the energy could be sent.

[0042] The distance computation system 24 determines the distance based on the data received from the projected energy generating device 20 and from the energy receiving device 22 and about the surface 26(2) of the distance measuring system which is being used as the reference plane. More specifically, the distance computation system 24 receives data on a propagation time of the received portion of the energy from a start time when the projected energy generating device 20 transmits the energy to a received time when the energy receiving device 22 receives the portion of the energy which is reflected back and uses this information with the identification of the surface used as the reference plane to determine distance. Since the surface 26(2) coincides with the desired plane of the origination object OB for the measurement, the distance computation system 24

adds in a distance substantially equal to the distance from the surface 26(1) to the surface 26(2). Again, the process of determining distance based on the time it takes projected energy PE to be reflected back from a target is well known to those of ordinary skill in the art and thus will not be described in detail here.

- 5 After the distance is computed by the distance computation system 24, the distance is transmitted to and displayed on the liquid crystal alphanumeric display device 14.

[0043] Accordingly, as the above-described operations illustrate, the present invention provides distance measuring systems that are accurate and 10 simple to use. The distance measuring systems 10(1) and 10(2) can be used to measure a distance with one hand without the need for the input of any other additional information.

[0044] Having thus described the basic concept of the invention, it will be rather apparent to those skilled in the art that the foregoing detailed disclosure is 15 intended to be presented by way of example only, and is not limiting. Various alterations, improvements, and modifications will occur and are intended to those skilled in the art, though not expressly stated herein. These alterations, improvements, and modifications are intended to be suggested hereby, and are within the spirit and scope of the invention. Additionally, the recited order of 20 processing elements or sequences, or the use of numbers, letters, or other designations therefor, is not intended to limit the claimed processes to any order except as may be specified in the claims. Accordingly, the invention is limited only by the following claims and equivalents thereto.